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For: METHOD OF CONTROLLING TELEPHONE CONNECTIONS FOR INTERNET PROTOCOL COMMUNICATIONS

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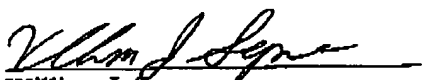
SUBSTITUTE SPECIFICATION

I hereby certify that the enclosed substitute specification contains the changes indicated in the enclosed marked-up copy of the original specification and abstract, and that no new matter is included in the substitute specification and abstract.

Respectfully submitted,



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Method of Controlling Telephone Connections for Internet Protocol Communications

Field of the Invention

The present invention relates generally to Internet Protocol (IP) telephony, and more particularly to a method of controlling IP telephones within a LAN-implemented or Ethernet PBX using a specialized messaging protocol.

Background of the Invention

With the increasing pervasiveness of the Internet, Voice-over-IP (VoIP) is rapidly displacing traditional TDM (Time Division Multiplexing) voice communications. In order to establish communications with Ethernet PBXs, an IP transport control messaging protocol is required to be established between the phone and PBX system.

Summary Of The Invention

According to the present invention, a method of controlling telephone connections for internet protocol communications comprises providing a byte oriented and easily adaptable messaging protocol for wrapping communications between IP telephones and Ethernet voice-LAN systems. The messages are required to implement essential tasks such as IP phone registration with the system upon phone power up or reset, the application of device tones to IP phones, and connection control for establishing full-duplex voice paths between IP phones. The messaging protocol of the invention also supports additional administrative and telephony functions.

The messaging protocol for wrapping the messages utilizes a general message template having a Protocol Header and an IP Message body. The Protocol Header, in turn, includes an indication of the Protocol Type, Device Number and Message Type.

The Device Number identifies the entity sharing the same MAC (Media Access Control) address that the messages are destined to or coming from. Message Type identifies the type of message contained in the IP Message Body. The Protocol Type denotes whether the message is an IP message (e.g. Mitel proprietary Minet IP message) or an encapsulated non-IP message (e.g. Mitel proprietary Minet (MTS 22) message). The Minet (MTS 22) messaging protocol is implemented in Mitel PBX models SX50, SX200, SX2000, IPERA 2000 for communicating with associated telephones such as Mitel models SS4001, SS4015, SS4025, SS4150, SS4015IP and SS4025IP.

Brief Description Of The Drawings

A preferred embodiment of the present invention will now be described more fully with reference to the accompanying drawings in which:

Figure 1 is a message flow diagram showing registration of an IP phone with an Ethernet PBX; and

Figures 2 is a message flow diagram showing the establishment of a full duplex voice path between a pair of IP phones.

Detailed Description Of The Preferred Embodiment

The method of controlling telephone connections for internet protocol communications using the messaging protocol which encapsulate a collection of specific messages of the present invention have particular application to the assignee's legacy mix of assembly and higher level languages. Consequently, reference to Minet and MinetIP messages occur throughout this disclosure to indicate the preferred embodiment and best mode implementation of the invention.

The Minet messaging extensions are structure based and are long word aligned, the result of which is that a user with a packet Sniffer will detect filler bytes in between short and long words.

In order to control a Mitel IP Phone, both Minet and Minet IP messages are required. A common message wrapper is defined to house the messages. The general message template consists of a Protocol Header and a Minet IP Message body that may or may not consist of an MTS22 Minet payload "wrapper".

Protocol Header:

ProtoType:	4 bytes , unsigned long integer, Protocol Type
devNum:	4 bytes , unsigned long integer, Device Number
msgType:	4 bytes , unsigned long integer, Message Type

The message body follows the Protocol Header as shown in the structure below:

```
typedef struct _IPSP_MSG {
        PROTOCOL_HEADER_MSG hdr;
        union _msg {
                MINET_WRAPPER_MSG               MWM;
                DEVICE_REGISTRATION_MSG         DRM;
                DEVICE_REGISTRATION_ACK_MSG     DRAM;
                DEVICE_UNREGISTER_MSG                   DUM;
                DEVICE_UNREGISTER_ACK_MSG       DUAM;
                OPEN_RX_STREAM_REQUEST_MSG      ORSRM;
                OPEN_RX_STREAM_ACK_MSG          ORSAM;
                CLOSE_RX_STREAM_REQUEST_MSG     CRSRM;
                CLOSE_RX_STREAM_ACK_MSG         CRSAM;
                OPEN_TX_STREAM_REQUEST_MSG      OTSRM;
                OPEN_TX_STREAM_ACK_MSG          OTSAM;
                CLOSE_TX_STREAM_REQUEST_MSG     CTSRM;
                CLOSE_TX_STREAM_ACK_MSG         CTSAM;
                APPLY_TONE_REQUEST_MSG          ATRM;
                REMOVE_TONE_REQUEST_MSG         RTRM;
                DEVICE_PING_REQUEST_MSG         DPRM;
                DEVICE_PING_ACK_MSG             DPAM;
                DEVICE_IP_UPDATE_REQUEST_MSG    DIURM;
                DEVICE_IP_UPDATE_ACK_MSG        DIUAM;
        } msg;
} IPSP_MSG;

typedef struct {
        protocolType_t      protoType;
        deviceNumber_t      devNum;
        messageType_t       msgType;
} PROTOCOL_HEADER_MSG;
```

Protocol Type:

INVALID_PROTOCOL_TYPE	0x00000000
MINET_MTS22	0x00000001
MITEL_INTERNAL	0x00000002

The Protocol Type denotes whether the message is a Minet IP message or an encapsulated Minet (MTS 22) message.

Device Number:

Phone	0x00000000
Device #1 i.e. PKM	0x00000001
Device #2	0x00000002
.....	.....
Device #n	0x0000000n

The Device Number denotes which entity ~~sharing~~ shares the same MAC address with the entity the messages are destined to or coming from.

Message Type:

INVALID_MESSAGE_TYPE	0x00000000
DEVICE_REGISTRATION	0x00000001
DEVICE_REGISTRATION_ACK	0x00000002
DEVICE_DEREGISTRATION	0x00000003
DEVICE_DEREGISTRATION_ACK	0x00000004
OPEN_RX_STREAM	0x00000005
OPEN_RX_STREAM_ACK	0x00000006
CLOSE_RX_STREAM	0x00000007
CLOSE_RX_STREAM_ACK	0x00000008
OPEN_TX_STREAM	0x00000009
OPEN_TX_STREAM_ACK	0x0000000a
CLOSE_TX_STREAM	0x0000000b
CLOSE_TX_STREAM_ACK	0x0000000c
MINET_WRAPPER	0x0000000d
APPLY_TONE	0x0000000e
REMOVE_TONE	0x0000000f
DEVICE_PING	0x00000010
DEVICE_PING_ACK	0x00000011
DEVICE_IP_UPDATE	0x00000012
DEVICE_IP_UPDATE_ACK	0x00000013
INVALID_MSG_TYPE	0x00000014

The above referenced message protocol is used to wrap or encapsulate each message sent and/or received by the IP phone or PBX. The following are examples of the use of the message protocol in reference to specific messages sent between IP telephones and Ethernet voice-LAN PBX systems. Each example begins by listing the Protocol header, Device Number and Message type.

Minet IP Registration Sequence

As shown in Figure 1, when the IP Phone 1 powers up or resets, it must register with the PBX 3. The phone 1 originates a Registration Request and receives a Registration Acknowledgement in return. The PBX 3 checks the Device ID of the phone (its MAC address) and verifies if it has the Device ID in the CDE database. If not, the system sends the phone 1 an MTS22 Minet for PIN Request. The phone buffers the key entries and sends up one message containing the PIN Reply (also an MTS22 Minet message).

The following messages are generated and exchanged between the IP phone and the PBX to register and de-register the phone 1 with the PBX 3:

Device Registration request message sent from the IP Phone

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_REGISTRATION

DEVICE_REGISTRATION_MSG

devId:		6 unsigned byte array
	mac_addr[6]	MAC address of Phone.
		Note that due to long word alignment, there may be 2 bytes of filler between the MAC address and the next defined field.
devType:		4 bytes , unsigned long integer, Type of device (i.e., SET, PKM, ...)
devNumber:		4 bytes , unsigned long integer, Number of device: Master, Slave01, Slave02, ...
ipAddress:		structure
	ip_addr	4 bytes , unsigned long integer, IP Address of device,
	ip_port	2 bytes , unsigned short integer, port number of protocol medium.

Note that due to long word alignment, there may be two bytes of filler between this field and the next.

DeviceCaps: structure: Functionality supported by this device

- strmCodec: 4 bytes, unsigned long integer (bitmap), System selected CODEC to use. Multiple CODECs may be logically Ored into this field.
- numTxStreams: 4 bytes, unsigned long integer, Number of Tx streams supported by the device
- numRxStreams: 4 bytes, unsigned long integer, Number of Rx streams supported by the device
- prefStrmFrameSizeInMS: 4 bytes, unsigned long integer, Devices preferred frame size for streams (in ms)
- silenceSupp: 4 bytes, unsigned long integer:
  silenceSupp=0: device does not support silence suppression
  silenceSupp=1: device supports silence suppression
- toneGeneration: 4 bytes, unsigned long integer:
  toneGeneration =0: device does not support local tone generation.
  toneGeneration =1: device supports local tone generation

Device Registration request Acknowledgment message sent from system

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_REGISTRATION_ACK

DEVICE_REGISTRATION_ACK_MSG

- reqStatus: 4 bytes, unsigned long integer, Success/Failure Result of the request
- sysToken: 4 bytes, unsigned long integer, System defined "token" that must be passed back with any follow up message related to this message i.e. Device Unregister.

Device De-Registration Request message sent from IP Phone.

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_DEREGISTRATION

Note that the IP Phone will not unregister itself, but rather an associated device such as a PKM may be removed and hence deregistered.

DEVICE_UNREGISTER_MSG

sysToken:	4 bytes , unsigned long integer, System defined "token" taken from the Registration Acknowledgment from the system.	
devType:	4 bytes , unsigned long integer, Type of device (i.e., SET, PKM, etc...)	
devNumber:	4 bytes , unsigned long integer, Number of device: Master, Slave01, Slave02, ...	
ipAddress:	structure	
	ip_addr	4 bytes , unsigned long integer, IP Address of device,
	ip_port	2 bytes , unsigned short integer, port number of protocol medium.

Device De-Registration Acknowledgment message sent from system

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_DEREGISTRATION_ACK

DEVICE_UNREGISTER_ACK_MSG

reqStatus:	4 bytes , unsigned long integer, Success/Failure Result of the request
devNumber:	4 bytes , unsigned long integer, Number of device: Master, Slave01, Slave02, ...

Detailed Description of Registration Parameters

devType:

INVALID_DEVICE_TYPE	0x00000000
IP_SUPERSET4001	0x00000001
IP_SUPERSET4015	0x0000009f
IP_SUPERSET4025	0x000000a0
IP_SUPERSET4150	0x00000004
PKM	0x00000005
AIM	0x00000006
SYMBOL_PROXY	0x00000007
SYMBOL_SET	0x00000008
TELEWORKER_PROXY	0x00000009
TELEWORKER_SET	0x0000000a
E2T_PROXY	0x0000000b
MAX_DEVICE_TYPE	0x0000000c

devNumbers:

MASTER_DEVICE 0x00000000
Where Set=0, and any attached devices will be numbered MASTER_DEVICE + n where n >= 1

reqStatus (Success/failure codes):

MTL_SUCCESS	0x00000000
MTL_FAILURE	0x00000001
MTL_NO_PERMISSIONS	0x00000002
MTL_NO_RESOURCES	0x00000003
MTL_INVALID_DEVICE	0x00000004
MTL_INVALID_REQUEST	0x00000005

devCodecs bitmap:

NO_CODEC_SUPPORT	0x0	(000 00000000)
G711_ULAW64	0x1	(000 00000001)
G711_ALAW64	0x2	(000 00000010)
G728	0x4	(000 00000100)
G729	0x8	(000 00001000)
G729_ANNEXB	0x10	(000 00010000)
G729_ANNEXA_w_ANNEXB	0x20	(000 00100000)
G723	0x40	(000 01000000)
G7231_ANNEXC	0x80	(000 10000000)
Placeholder1	0x100	(001 00000000)
Placeholder2	0x200	(010 00000000)
Placeholder3	0x400	(100 00000000)
INVALID_CODEC	0x7FF	(111 11111111)

For system maintenance purposes, it is desirable to provide a mechanism for testing the presence of an operating IP phone 1 in the system by generation of echo (PING) messages to the phone 1. The following messages are generated and exchanged between the IP phone and the PBX to implement this functionality:

Device ICMP Echo (Ping) request to the phone
ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_PING

DEVICE PING REQUEST MSG

hostIpAddress:		structure
	ip_addr	4 bytes , unsigned long integer, IP Address of device to PING,
	ip_port	2 bytes , unsigned short integer, port number is IGNORED.
		Note that due to long word alignment, there may be two bytes of filler following this field.
numRequests		4 bytes , unsigned long integer, Number of ping requests to send
pktSize		4 bytes , unsigned long integer, Size of data packet to send (in bytes)
pktDelay		4 bytes , unsigned long integer, Inter packet delay in Milliseconds
timeOut		4 bytes , unsigned long integer, Ping request timeout in Milliseconds
qosLevel		4 bytes , unsigned long integer, QOS level requested

Device ICMP Echo (Ping) results sent from the phone to the system

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_PING_ACK

DEVICE PING ACK MSG

hostIpAddress:		structure
	ip_addr	4 bytes , unsigned long integer, IP Address of device that was PINGed,
	ip_port	2 bytes , unsigned short integer, port number is IGNORED.
		Note that due to long word alignment, there may be two bytes of filler following this field.
pktsSent		4 bytes , unsigned long integer, Number of ICMP echo requests sent
pktsRecv		4 bytes , unsigned long integer, Number of ICMP echo replys received
pktLoss		4 bytes , unsigned long integer, Percentage of packets lost
rttMax		4 bytes , unsigned long integer, Maximum round trip time (in milliseconds)
rttMin		4 bytes , unsigned long integer, Minimum round trip time (in milliseconds)
rttAvg		4 bytes , unsigned long integer, Average round trip time (in milliseconds)

Detailed Description of PING Parameters

qosLevel:

QOS_LEVEL_NONE	0xffffffff
QOS_LEVEL_0	0x00000000
QOS_LEVEL_1	0x00000001
QOS_LEVEL_2	0x00000002
QOS_LEVEL_3	0x00000003
QOS_LEVEL_4	0x00000004
QOS_LEVEL_5	0x00000005
QOS_LEVEL_6	0x00000006
QOS_LEVEL_7	0x00000007

Once the IP phone 1 has been registered with PBX 3, and in response to a user going off-hook, the PBX 3 is required to provide tones to the phone in order to provide the user with an indication of the call state (e.g. dial tone, busy, etc.) The following messages are generated and exchanged between the IP phone and the PBX for providing device tones to the phone 1:

Apply Tone device tone generation request message to the phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = APPLY_TONE

APPLY_TONE_REQUEST_MSG

sysToken:	4 bytes , unsigned long integer, System defined "token" that must be passed back with the Remove Tone request.
sysStrmID:	4 bytes , unsigned long integer, System provided stream ID which maps the voice streams to legacy B channels
tone[MAX_COMPLEX_TONE]:	array of tone structures of frequencies the DSP is to play
on_T1	2 bytes, unsigned long integer, Duration in ms of 1st ON period
off_T1	2 bytes, unsigned long integer, Duration in ms of 1st OFF period
on_T2	2 bytes, unsigned long integer, Duration in ms of 2nd ON period
off_T2	2 bytes, unsigned long integer, Duration in ms of 2nd OFF period
num_cycles	2 bytes, unsigned long integer, Number of times to repeat the ON/OFF sequence
tail	2 bytes, unsigned long integer, After num_cycles, 0 = leave tone off, 1 = on
freq_1	2 bytes, unsigned long integer, 1st frequency component in Hz

freq_2	2 bytes, unsigned long integer, 2nd frequency component in Hz
level_1	2 bytes, unsigned long integer, 1st frequency signal level
level_2	2 bytes, unsigned long integer, 2nd frequency signal level
action	2 bytes, unsigned long integer, indicates the action to take on completion of the tone. The actions are either to continue to the next tone descriptor, reconnect to the audio stream, or just stop. Note that due to long word alignment, there may be 2 bytes of filler following this field.
toneId:	4 bytes , unsigned long integer, System Tone ID of the tone being applied
inject;	4 bytes , unsigned long integer, specify whether to inject the tone on top of voice or not. This is unused by the phone since the tone will always take precedence over voice.

Remove Tone device tone generation request message to the phone

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = REMOVE_TONE

REMOVE_TONE_REQUEST_MSG

sysToken:	4 bytes , unsigned long integer, System defined "token" that was given with the Apply Tone request.
sysStrmID:	4 bytes , unsigned long integer, System provided stream ID which maps the voice streams to legacy B channels
tone[MAX_COMPLEX_TONE]:	array of tone structures of frequencies the DSP was playing out to the CODEC that it is to remove. Note that this is IGNORED BY IP PHONE
on_T1	2 bytes, unsigned long integer, Duration in ms of 1st ON period
off_T1	2 bytes, unsigned long integer, Duration in ms of 1st OFF period
on_T2	2 bytes, unsigned long integer, Duration in ms of 2nd ON period
off_T2	2 bytes, unsigned long integer, Duration in ms of 2nd OFF period
num_cycles	2 bytes, unsigned long integer, Number of times to repeat the ON/OFF sequence
tail	2 bytes, unsigned long integer, After num_cycles, 0 = leave tone off, 1 = on
freq_1	2 bytes, unsigned long integer, 1st frequency component in Hz
freq_2	2 bytes, unsigned long integer, 2nd frequency component in Hz
level_1	2 bytes, unsigned long integer, 1st frequency signal level
level_2	2 bytes, unsigned long integer, 2nd frequency signal level
action	2 bytes, unsigned long integer, indicates the action to take on completion of the tone. The actions are either to continue to the next tone descriptor, reconnect to the audio stream, or just stop.

Detailed Description of TONE Parameters

inject:

NOT_INJECTED	0x00000000
NORMAL_INJECTION	0x00000001
MAX_TONE_INJECT	0x00000002
MAX_COMPLEX_TONE	3

action:

NEXT	0x00000000
RECONNECT	0x00000001
STOP	0x00000002

Figure 2 is a message flow diagram showing the messages required to establish communications between a pair of IP phones 1A and 1B via an IP Phone Service Provider 5 of PBX 3. The following messages are generated and exchanged between the IP phones and the PBX to implement such communications:

Open Receive Stream Request to the phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = OPEN_RX_STREAM

OPEN_RX_STREAM_REQUEST_MSG

sysToken:		4 bytes, unsigned long integer, System defined "token" that must be passed back with the corresponding Close Receive Stream Request.
sysStrmID:		4 bytes, unsigned long integer, System provided stream ID. This field denotes the B channel the connection should assume.
strmCodec		4 bytes, unsigned long integer (bitmap), System selected CODEC to use. Multiple CODECs may be logically Ored into this field.
strmFrameSizeInMS		4 bytes, unsigned long integer, Preferred CODEC frame size for the RX stream (in milliseconds)
isMulticast		4 bytes, unsigned long integer isMulticast =0: no Multicast, ignore mcIpAddress. isMulticast =1: the stream must be bound to the mcIpAddress Multicast address.
mcIpAddress:		structure
	ip_addr	4 bytes, unsigned long integer, Multicast address to receive on

	ip_port	2 bytes , unsigned short integer, Multicast port number to receive on.
		Note that due to long word alignment, there may be two bytes of filler following this field.
SrcIpAddress:		structure: IGNORED BY THE IP PHONE.
	ip_addr	4 bytes, unsigned long integer, The ip address of the device that will be transmitting to the phone.
	ip_port	2 bytes , unsigned short integer, port number used by the device that will be transmitting to the phone.
		Note that due to long word alignment, there may be two bytes of filler following this field.
noSilence		4 bytes, unsigned long integer, noSilence =0: no silence suppression applied by the transmitting end noSilence =1: silence suppression is being applied by the transmitting end

Open Receive Stream Acknowledgement from the IP Phone to the system:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = OPEN_RX_STREAM_ACK

OPEN_RX_STREAM_ACK_MSG

reqStatus:		4 bytes, unsigned long integer, Success/Failure Result of the request
sysToken:		4 bytes, unsigned long integer, System provided "token" from the request message
rxConnectionID:		4 bytes, unsigned long integer, Device selected stream/connection identifier. The IP Phone returns the value of the sysStrmID (B channel) in this field
rxStrmIpAddress:		structure
	ip_addr	4 bytes, unsigned long integer, The local ip address that will receive stream
	ip_port	2 bytes , unsigned short integer, local port number to receive on.

Close Receive Stream Request from the system to the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = CLOSE_RX_STREAM

CLOSE_RX_STREAM_REQUEST_MSG

sysToken:	4 bytes, unsigned long integer, System defined "token" that was given with the Open Receive Stream Request.
sysStrmID:	4 bytes, unsigned long integer, Id of RX stream/connection (B channel) to close

Close Receive Stream Acknowledgement from the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = CLOSE_RX_STREAM_ACK

CLOSE_RX_STREAM_ACK_MSG

reqStatus:	4 bytes, unsigned long integer, Success/Failure Result of the request
sysToken:	4 bytes, unsigned long integer, System provided "token" from the request message
rxStrmStats:	structure: Stream statistics upon closure
Packets.recv	4 bytes, unsigned long integer, number of RTP packets received
Bytes.recv	4 bytes, unsigned long integer, number of voice octets received
Errors.rxStream	4 bytes, unsigned long integer, number of RTP errors received
Jitter.rxStream	4 bytes, unsigned long integer, estimate of average jitter over duration of call.
Duration.rxStream	4 bytes, unsigned long integer, duration of call in seconds
IpAddress.src:	structure
ip_addr	4 bytes, unsigned long integer, the local ip address
ip_port	2 bytes , unsigned short integer, the local port number.

Open Transmit Stream Request to the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = OPEN_TX_STREAM

OPEN_TX_STREAM_REQUEST_MSG

sysToken:	4 bytes, unsigned long integer, System defined "token" that must be passed back with the corresponding Close Transmit Stream Request.
sysStrmID:	4 bytes, unsigned long integer, System provided stream ID. This field denotes the B channel the connection should assume.
strmCodec	4 bytes, unsigned long integer (bitmap), System selected CODEC to use. Multiple CODECs may be logically Ored into this field.

strmFrameSizeInMS	4 bytes, unsigned long integer, Preferred CODEC frame size for the TX stream (in milliseconds)
destStrmIpAddress:	structure
ip_addr	4 bytes, unsigned long integer, The IP address of the device to transmit to.
ip_port	2 bytes , unsigned short integer, port number used by the device that will be transmitting to the phone. Note that due to long word alignment, there may be two bytes of filler following this field.
qosLevel	4 bytes, unsigned long integer, QoS level requested. If 0xffffffff, then no 802.1Q tag, else if 0-7, assume 802.1Q tag and set priority field to the qosLevel
noSilence	4 bytes, unsigned long integer noSilence =0: disable silence suppression on the Tx stream noSilence =1: enable silence suppression on the Tx stream

Open Transmit Stream Acknowledgement from the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = OPEN_TX_STREAM_ACK

OPEN_TX_STREAM_ACK_MSG

reqStatus:	4 bytes, unsigned long integer, Success/Failure Result of the request
sysToken:	4 bytes, unsigned long integer, System provided "token" from the request message
txConnectionID:	4 bytes, unsigned long integer, Device selected stream/connection identifier. The IP Phone returns the value of the sysStrmID (B channel) in this field
txStrmIpAddress:	structure
ip_addr	4 bytes, unsigned long integer, The local IP address that will transmit stream
ip_port	2 bytes , unsigned short integer, local port number the phone will transmit from.

Close Transmit Stream Request to the IP Phone

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = CLOSE_TX_STREAM

CLOSE_TX_STREAM_REQUEST_MSG

sysToken:	4 bytes, unsigned long integer, System defined "token" that was given with the Open Transmit Stream Request .

sysStrmID:	4 bytes, unsigned long integer, id of TX stream/connection (B channel) to close

Close Transmit Stream Acknowledgement from the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = CLOSE_TX_STREAM_ACK

CLOSE_TX_STREAM_ACK_MSG

reqStatus:	4 bytes, unsigned long integer, Success/Failure Result of the request
sysToken:	4 bytes, unsigned long integer, System provided "token" from the request message
txStrmStats:	structure: Stream statistics upon closure
Packets.sent	4 bytes, unsigned long integer, number of RTP packets sent
Bytes.sent	4 bytes, unsigned long integer, number of voice octets sent
Errors.txStream	4 bytes, unsigned long integer, number of RTP errors sent. IGNORE, NOT RELEVENT
Jitter.txStream	4 bytes, unsigned long integer, estimate of average jitter over duration of call. IGNORE, NOT RELEVENT
Duration.txStream	4 bytes, unsigned long integer, duration of call in seconds
IpAddress.dest:	structure
ip_addr	4 bytes, unsigned long integer, the local IP address used to Tx
ip_port	2 bytes , unsigned short integer, the local port number used to Tx.

Detailed Description of Connection Parameters

reqStatus (Success/failure codes):

MTL_SUCCESS	0x00000000
MTL_FAILURE	0x00000001
MTL_NO_PERMISSIONS	0x00000002
MTL_NO_RESOURCES	0x00000003
MTL_INVALID_DEVICE	0x00000004
MTL_INVALID_REQUEST	0x00000005

SysStrmID:
IP Set Stream IDs: (NOTE: TX is always even) used for sysStrmID of Tx & Rx connect requests

STREAM_ID_IP_SET_TX_1	0x00000000	// B1 TX
STREAM_ID_IP_SET_RX_1	0x00000001	// B1 RX
STREAM_ID_IP_SET_TX_2	0x00000002	// B2 TX
STREAM_ID_IP_SET_RX_2	0x00000003	// B2 RX

devCodecs bitmap:

NO_CODEC_SUPPORT	0x0	(000 00000000)
G711_ULAW64	0x1	(000 00000001)
G711_ALAW64	0x2	(000 00000010)
G728	0x4	(000 00000100)
G729	0x8	(000 00001000)
G729_ANNEXB	0x10	(000 00010000)
G729_ANNEXA_w_ANNEXB	0x20	(000 00100000)
G723	0x40	(000 01000000)
G7231_ANNEXC	0x80	(000 10000000)
Placeholder1	0x100	(001 00000000)
Placeholder2	0x200	(010 00000000)
Placeholder3	0x400	(100 00000000)
INVALID_CODEC	0x7FF	(111 11111111)

qosLevel:

QOS_LEVEL_NONE	0xffffffff
QOS_LEVEL_0	0x00000000
QOS_LEVEL_1	0x00000001
QOS_LEVEL_2	0x00000002
QOS_LEVEL_3	0x00000003
QOS_LEVEL_4	0x00000004
QOS_LEVEL_5	0x00000005
QOS_LEVEL_6	0x00000006
QOS_LEVEL_7	0x00000007

One important system administration requirement for IP phone systems is to provide a mechanism for updating the IP address for a device (e.g. an IP phone) connected to the Ethernet PBX 3. The following messages are generated and exchanged between the IP phone and the PBX to implement this functionality:

Device IP address update request to the phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_IP_UPDATE

DEVICE_IP_UPDATE_REQUEST_MSG

devNumber		4 bytes , unsigned long integer, Number of device: Master, Slave01, Slave02, ...
oldIpAddress:		structure
	ip_addr	4 bytes , unsigned long integer, old IP Address of device

	ip_port	2 bytes , unsigned short integer, old port number of device Note that due to long word alignment, there may be two bytes of filler following this field.
newIpAddress:		structure
	ip_addr	4 bytes , unsigned long integer, new IP Address of device
	ip_port	2 bytes , unsigned short integer, new port number of device

Device IP address update acknowledgement from the phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_IP_UPDATE_ACK

DEVICE_IP_UPDATE_ACK_MSG

reqStatus:	4 bytes , unsigned long integer, Success/Failure Result of the request

Parameters Description

reqStatus (Success/failure codes):

MTL_SUCCESS	0x00000000
MTL_FAILURE	0x00000001
MTL_NO_PERMISSIONS	0x00000002
MTL_NO_RESOURCES	0x00000003
MTL_INVALID_DEVICE	0x00000004
MTL_INVALID_REQUEST	0x00000005

devNumbers:

MASTER_DEVICE 0x00000000
Where Set=0, and any attached devices will be numbered MASTER_DEVICE + n where n >= 1

Finally, as indicated above, the messaging protocol of the present invention allows for the encapsulation of "legacy" Minet messages (i.e. MTS 22 messages) to and from the IP phones. The following message format is used:

Wrapper structure for MINET messages to and from the IP Phone:

ProtoType = MINET_MTS22
DevNum = N where N=0,1,2,....n

msgType = MINET_WRAPPER

MINET_WRAPPER_MSG

msgLen:	4 bytes , unsigned long integer, length of the following MINET message.
msg[MAX_MINET_SIZE]	array unsigned char, the MTS22 MINET message

Parameters Description

MAX_MINET_SIZE 160

In summary, according to the present invention, a method of controlling telephone connections for internet protocol communications comprises providing a messaging protocol for wrapping or encapsulating messages exchanged between an IP phone and a PBX, the message protocol using a general message template having a Protocol Header and an IP Message body, along with a collection of messages which conform to the protocol, for controlling IP phones within an Ethernet-based PBX system. The invention has particular applicability as a message interface method for use in communication from Mitel's IP Phones to Mitel's IP enabled PBXs. The message interface method is compatible with an H323 Voice Gateway implementation.

Alternatives and variations of the invention are possible. For example, the protocol can be adapted to control voice/data switching on any IP centric node. In other words, the protocol is not constrained to phones but, rather, can be applied to any internet appliance that is a client to the IP centric PBX. Within the PBX, the protocol can be used by call control in order to control the switching fabric. All such embodiments, modifications and applications are believed to be within the sphere and scope of the invention as defined by the claims appended hereto.

I Claim:

MARKED-UP COPY OF SPECIFICATION AND ABSTRACT

Method of Controlling Telephone Connections for Internet Protocol Communications

Field of the Invention

The present invention relates generally to Internet Protocol (IP) telephony, and more particularly to a method of controlling IP telephones within a LAN-implemented or Ethernet PBX using a specialized messaging protocol.

Background of the Invention

With the increasing pervasiveness of the Internet, Voice-over-IP (VoIP) is rapidly displacing traditional TDM (Time Division Multiplexing) voice communications. In order to establish communications with Ethernet PBXs, an IP transport control messaging protocol is required to be established between the phone and PBX system.

Summary Of The Invention

According to the present invention, a method of controlling telephone connections for internet protocol communications comprises providing a byte oriented and easily adaptable messaging protocol [~~is provided~~] for wrapping communications between IP telephones and Ethernet voice-LAN systems. The messages are required to implement essential tasks such as IP phone registration with the system upon phone power up or reset, the application of device tones to IP phones, and connection control for establishing full-duplex voice paths between IP phones. The messaging protocol of the invention also supports additional administrative and telephony functions.

The messaging protocol for wrapping the messages utilizes a general message template ~~consists of~~ having a Protocol Header and an IP Message body. The Protocol Header, in turn, includes an indication of the Protocol Type, Device Number and Message Type. The Device Number identifies the entity sharing the same MAC (Media Access Control) address that the messages are destined to or coming from. Message Type identifies the type of message contained in the IP Message Body. The Protocol Type denotes whether the message is an IP message (e.g. Mitel proprietary Minet IP message) or an encapsulated non-IP message (e.g. Mitel proprietary Minet (MTS 22) message). The Minet (MTS 22) messaging protocol is implemented in Mitel PBX models SX50, SX200, SX2000, IPERA 2000 for communicating with associated telephones such as Mitel models SS4001, SS4015, SS4025, SS4150, SS4015IP and SS4025IP.

Brief Description Of The Drawings

A preferred embodiment of the present invention will now be described more fully with reference to the accompanying drawings in which:

Figure 1 is a message flow diagram showing registration of an IP phone with an Ethernet PBX; and

Figures 2 is a message flow diagram showing the establishment of a full duplex voice path between a pair of IP phones.

Detailed Description Of The Preferred Embodiment

The method of controlling telephone connections for internet protocol communications using the messaging protocol which encapsulate a ~~and~~ collection of specific messages of the present invention have particular application to the assignee's legacy mix of assembly and higher level languages. Consequently, reference to Minet

and MinetIP messages occur throughout this disclosure to indicate the preferred embodiment and best mode implementation of the invention.

The Minet messaging extensions are structure based and are long word aligned, the result of which is that a user with a packet Sniffer will detect filler bytes in between short and long words.

In order to control a Mitel IP Phone, both Minet and Minet IP messages are required. A common message wrapper is defined to house the messages. The general message template consists of a Protocol Header and a Minet IP Message body that may or may not consist of an MTS22 Minet payload "wrapper".

Protocol Header:

ProtoType:	4 bytes , unsigned long integer, Protocol Type
devNum:	4 bytes , unsigned long integer, Device Number
msgType:	4 bytes , unsigned long integer, Message Type

The message body follows the Protocol Header as shown in the structure below:

```
typedef struct _IPSP_MSG {
        PROTOCOL_HEADER_MSG hdr;
        union _msg {
                MINET_WRAPPER_MSG               MWM;
                DEVICE_REGISTRATION_MSG         DRM;
                DEVICE_REGISTRATION_ACK_MSG     DRAM;
                DEVICE_UNREGISTER_MSG                   DUM;
                DEVICE_UNREGISTER_ACK_MSG       DUAM;
                OPEN_RX_STREAM_REQUEST_MSG      ORSRM;
                OPEN_RX_STREAM_ACK_MSG          ORSAM;
                CLOSE_RX_STREAM_REQUEST_MSG     CRSRM;
                CLOSE_RX_STREAM_ACK_MSG         CRSAM;
                OPEN_TX_STREAM_REQUEST_MSG      OTSRM;
                OPEN_TX_STREAM_ACK_MSG          OTSAM;
                CLOSE_TX_STREAM_REQUEST_MSG     CTSRM;
                CLOSE_TX_STREAM_ACK_MSG         CTSAM;
                APPLY_TONE_REQUEST_MSG          ATRM;
                REMOVE_TONE_REQUEST_MSG         RTRM;
                DEVICE_PING_REQUEST_MSG         DPRM;
                DEVICE_PING_ACK_MSG             DPAM;
                DEVICE_IP_UPDATE_REQUEST_MSG    DIURM;
                DEVICE_IP_UPDATE_ACK_MSG        DIUAM;
        } msg;
} IPSP_MSG;
```

```
typedef struct {
        protocolType_t      protoType;
        deviceNumber_t      devNum;
        messageType_t       msgType;
} PROTOCOL_HEADER_MSG;
```

Protocol Type:

INVALID_PROTOCOL_TYPE	0x00000000
MINET_MTS22	0x00000001
MITEL_INTERNAL	0x00000002

The Protocol Type denotes whether the message is a Minet IP message or an encapsulated Minet (MTS 22) message.

Device Number:

Phone	0x00000000
Device #1 i.e. PKM	0x00000001
Device #2	0x00000002
.....	.....
Device #n	0x0000000n

The Device Number denotes which entity ~~sharing~~ shares the same MAC address with the entity the messages are destined to or coming from.

Message Type:

INVALID_MESSAGE_TYPE	0x00000000
DEVICE_REGISTRATION	0x00000001
DEVICE_REGISTRATION_ACK	0x00000002
DEVICE_DEREGISTRATION	0x00000003
DEVICE_DEREGISTRATION_ACK	0x00000004
OPEN_RX_STREAM	0x00000005
OPEN_RX_STREAM_ACK	0x00000006
CLOSE_RX_STREAM	0x00000007
CLOSE_RX_STREAM_ACK	0x00000008
OPEN_TX_STREAM	0x00000009
OPEN_TX_STREAM_ACK	0x0000000a
CLOSE_TX_STREAM	0x0000000b
CLOSE_TX_STREAM_ACK	0x0000000c
MINET_WRAPPER	0x0000000d
APPLY_TONE	0x0000000e
REMOVE_TONE	0x0000000f
DEVICE_PING	0x00000010
DEVICE_PING_ACK	0x00000011

DEVICE_IP_UPDATE	0x00000012
DEVICE_IP_UPDATE_ACK	0x00000013
INVALID_MSG_TYPE	0x00000014

The above referenced message protocol is used to wrap or encapsulate each message sent and/or received by the IP phone or PBX. The following are examples of the use of the message protocol in reference to specific messages sent between IP telephones and Ethernet voice-LAN PBX systems. Each example begins by listing the Protocol header, Device Number and Message type.

Minet IP Registration Sequence

As shown in Figure 1, when the IP Phone 1 powers up or resets, it must register with the PBX 3. The phone 1 originates a Registration Request and receives a Registration Acknowledgement in return. The PBX 3 checks the Device ID of the phone (its MAC address) and verifies if it has ~~it~~ the Device ID in the CDE database. If not, the system sends the phone 1 an MTS22 Minet for PIN Request. The phone buffers the key entries and sends up one message containing the PIN Reply (also an MTS22 Minet message).

The following messages are generated and exchanged between the IP phone and the PBX ~~used~~ to register and de-register the phone 1 with the PBX 3:

Device Registration request message sent from the IP Phone

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_REGISTRATION

DEVICE_REGISTRATION_MSG

devId:		6 unsigned byte array
	mac_addr[6]	MAC address of Phone.
		Note that due to long word alignment, there may be 2 bytes of filler between the MAC address and the next defined field.
devType:		4 bytes, unsigned long integer, Type of device (i.e., SET, PKM, ...)

devNumber: 4 bytes , unsigned long integer, Number of device: Master, Slave01, Slave02, ...

ipAddress: structure

ip_addr 4 bytes , unsigned long integer, IP Address of device,

ip_port 2 bytes , unsigned short integer, port number of protocol medium.

Note that due to long word alignment, there may be two bytes of filler between this field and the next.

DeviceCaps: structure: Functionality supported by this device

strmCodec 4 bytes, unsigned long integer (bitmap), System selected CODEC to use. Multiple CODECs may be logically Ored into this field.

numTxStreams: 4 bytes , unsigned long integer, Number of Tx streams supported by the device

numRxStreams: 4 bytes , unsigned long integer, Number of Rx streams supported by the device

prefStrmFrameSizeInMS: 4 bytes , unsigned long integer, Devices preferred frame size for streams (in ms)

silenceSupp: 4 bytes , unsigned long integer:
silenceSupp=0: device does not support silence suppression
silenceSupp=1: device supports silence suppression

toneGeneration: 4 bytes , unsigned long integer:
toneGeneration =0: device does not support local tone generation.
toneGeneration =1: device supports local tone generation

Device Registration request Acknowledgment message sent from system

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_REGISTRATION_ACK

DEVICE REGISTRATION ACK MSG

reqStatus: 4 bytes , unsigned long integer, Success/Failure Result of the request

sysToken: 4 bytes , unsigned long integer, System defined "token" that must be passed back with any follow up message related to this message i.e. Device Unregister.

Device De-Registration Request message sent from IP Phone.

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgTypc = DEVICE_DEREGISTRATION

Note that the IP Phone will not unregister itself, but rather an associated device such as a PKM may be removed and hence deregistered.

DEVICE_UNREGISTER_MSG

sysToken:	4 bytes , unsigned long integer, System defined "token" taken from the Registration Acknowledgment from the system.
devType:	4 bytes , unsigned long integer, Type of device (i.e., SET, PKM, etc...)
devNumber:	4 bytes , unsigned long integer, Number of device: Master, Slave01, Slave02, ...
ipAddress:	structure
ip_addr	4 bytes , unsigned long integer, IP Address of device,
ip_port	2 bytes , unsigned short integer, port number of protocol medium

Device De-Registration Acknowledgment message sent from system

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_DEREGISTRATION_ACK

DEVICE_UNREGISTER_ACK_MSG

reqStatus:	4 bytes , unsigned long integer, Success/Failure Result of the request
devNumber:	4 bytes , unsigned long integer, Number of device: Master, Slave01, Slave02, ...

Detailed Description of Registration Parameters

devType:

INVALID_DEVICE_TYPE	0x00000000
IP_SUPERSET4001	0x00000001
IP_SUPERSET4015	0x0000009f
IP_SUPERSET4025	0x000000a0
IP_SUPERSET4150	0x00000004
PKM	0x00000005
AIM	0x00000006
SYMBOL_PROXY	0x00000007
SYMBOL_SET	0x00000008
TELEWORKER_PROXY	0x00000009

TELEWORKER_SET	0x0000000a
E2T_PROXY	0x0000000b
MAX_DEVICE_TYPE	0x0000000c

devNumbers:

MASTER_DEVICE 0x00000000
Where Set=0, and any attached devices will be numbered MASTER_DEVICE + n where n >= 1

reqStatus (Success/failure codes):

MTL_SUCCESS	0x00000000
MTL_FAILURE	0x00000001
MTL_NO_PERMISSIONS	0x00000002
MTL_NO_RESOURCES	0x00000003
MTL_INVALID_DEVICE	0x00000004
MTL_INVALID_REQUEST	0x00000005

devCodecs bitmap:

NO_CODEC_SUPPORT	0x0	(000 00000000)
G711_ULAW64	0x1	(000 00000001)
G711_ALAW64	0x2	(000 00000010)
G728	0x4	(000 00000100)
G729	0x8	(000 00001000)
G729_ANNEXB	0x10	(000 00010000)
G729_ANNEXA_w_ANNEXB	0x20	(000 00100000)
G723	0x40	(000 01000000)
G7231_ANNEXC	0x80	(000 10000000)
Placeholder1	0x100	(001 00000000)
Placeholder2	0x200	(010 00000000)
Placeholder3	0x400	(100 00000000)
INVALID_CODEC	0x7FF	(111 11111111)

For system maintenance purposes, it is desirable to provide a mechanism for testing the presence of an operating IP phone 1 in the system by generation of echo (PING) messages to the phone 1. The following messages are generated and exchanged between the IP phone and the PBX ~~used~~ to implement this functionality:

Device ICMP Echo (Ping) request to the phone

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_PING

DEVICE_PING_REQUEST_MSG

hostIpAddress:		structure
	ip_addr	4 bytes , unsigned long integer, IP Address of device to PING,
	ip_port	2 bytes , unsigned short integer, port number is IGNORED.
		Note that due to long word alignment, there may be two bytes of filler following this field.
numRequests		4 bytes , unsigned long integer, Number of ping requests to send
pktSize		4 bytes , unsigned long integer, Size of data packet to send (in bytes)
pktDelay		4 bytes , unsigned long integer, Inter packet delay in Milliseconds
timeOut		4 bytes , unsigned long integer, Ping request timeout in Milliseconds
qosLevel		4 bytes , unsigned long integer, QOS level requested

Device ICMP Echo (Ping) results sent from the phone to the system

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_PING_ACK

DEVICE_PING_ACK_MSG

hostIpAddress:		structure
	ip_addr	4 bytes , unsigned long integer, IP Address of device that was PINGed,
	ip_port	2 bytes , unsigned short integer, port number is IGNORED.
		Note that due to long word alignment, there may be two bytes of filler following this field.
pktsSent		4 bytes , unsigned long integer, Number of ICMP echo requests sent
pktsRecv		4 bytes , unsigned long integer, Number of ICMP echo replys received
pktLoss		4 bytes , unsigned long integer, Percentage of packets lost
rttMax		4 bytes , unsigned long integer, Maximum round trip time (in milliseconds)
rttMin		4 bytes , unsigned long integer, Minimum round trip time (in milliseconds)

rttAvg 4 bytes , unsigned long integer, Average round trip time (in milliseconds)

Detailed Description of PING Parameters

qosLevel:

QOS_LEVEL_NONE	0xffffffff
QOS_LEVEL_0	0x00000000
QOS_LEVEL_1	0x00000001
QOS_LEVEL_2	0x00000002
QOS_LEVEL_3	0x00000003
QOS_LEVEL_4	0x00000004
QOS_LEVEL_5	0x00000005
QOS_LEVEL_6	0x00000006
QOS_LEVEL_7	0x00000007

Once the IP phone 1 has been registered with PBX 3, and in response to a user going off-hook, the PBX 3 is required to provide tones to the phone in order to provide the ~~use~~ user with an indication of the call state (e.g. dial tone, busy, etc.) The following messages are generated and exchanged between the IP phone and the PBX ~~used for the provisioning of~~ for providing device tones to the phone 1:

Apply Tone device tone generation request message to the phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = APPLY_TONE

APPLY_TONE_REQUEST_MSG

sysToken:	4 bytes , unsigned long integer, System defined "token" that must be passed back with the Remove Tone request.
sysStrmID:	4 bytes , unsigned long integer, System provided stream ID which maps the voice streams to legacy B channels
tone[MAX_COMPLEX_TONE]:	array of tone structures of frequencies the DSP is to play
on_T1	2 bytes, unsigned long integer, Duration in ms of 1st ON period
off_T1	2 bytes, unsigned long integer, Duration in ms of 1st OFF period
on_T2	2 bytes, unsigned long integer, Duration in ms of 2nd ON period
off_T2	2 bytes, unsigned long integer, Duration in ms of 2nd OFF period
num_cycles	2 bytes, unsigned long integer, Number of times to repeat the ON/OFF sequence

	tail	2 bytes, unsigned long integer, After num_cycles, 0 = leave tone off, 1 = on
	freq_1	2 bytes, unsigned long integer, 1st frequency component in Hz
	freq_2	2 bytes, unsigned long integer, 2nd frequency component in Hz
	level_1	2 bytes, unsigned long integer, 1st frequency signal level
	level_2	2 bytes, unsigned long integer, 2nd frequency signal level
	action	2 bytes, unsigned long integer, indicates the action to take on completion of the tone. The actions are either to continue to the next tone descriptor, reconnect to the audio stream, or just stop. Note that due to long word alignment, there may be 2 bytes of filler following this field.
toneId:		4 bytes , unsigned long integer, System Tone ID of the tone being applied
inject;		4 bytes , unsigned long integer, specify whether to inject the tone on top of voice or not. This is unused by the phone since the tone will always take precedence over voice.

Remove Tone device tone generation request message to the phone

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = REMOVE_TONE

REMOVE_TONE_REQUEST_MSG

sysToken:		4 bytes , unsigned long integer, System defined "token" that was given with the Apply Tone request.
sysStrmID:		4 bytes , unsigned long integer, System provided stream ID which maps the voice streams to legacy B channels
tone[MAX_COMPLEX_TONE]:		array of tone structures of frequencies the DSP was playing out to the CODEC that it is to remove. Note that this is IGNORED BY IP PHONE
	on_T1	2 bytes, unsigned long integer, Duration in ms of 1st ON period
	off_T1	2 bytes, unsigned long integer, Duration in ms of 1st OFF period
	on_T2	2 bytes, unsigned long integer, Duration in ms of 2nd ON period
	off_T2	2 bytes, unsigned long integer, Duration in ms of 2nd OFF period
	num_cycles	2 bytes, unsigned long integer, Number of times to repeat the ON/OFF sequence
	tail	2 bytes, unsigned long integer, After num_cycles, 0 = leave tone off, 1 = on
	freq_1	2 bytes, unsigned long integer, 1st frequency component in Hz
	freq_2	2 bytes, unsigned long integer, 2nd frequency component in Hz
	level_1	2 bytes, unsigned long integer, 1st frequency signal level
	level_2	2 bytes, unsigned long integer, 2nd frequency signal level
	action	2 bytes, unsigned long integer, indicates the action to take on completion of the tone. The actions are either to continue to the next tone descriptor, reconnect to the audio stream, or just stop.

Detailed Description of TONE Parameters

inject:

NOT_INJECTED	0x00000000
NORMAL_INJECTION	0x00000001
MAX_TONE_INJECT	0x00000002
MAX_COMPLEX_TONE	3

action:

NEXT	0x00000000
RECONNECT	0x00000001
STOP	0x00000002

Figure 2 is a message flow diagram showing the messages required to establish communications between a pair of IP phones 1A and 1B via an IP Phone Service Provider 5 of PBX 3. The following messages are generated and exchanged between the IP phones and the PBX ~~required~~ to implement such communications:

Open Receive Stream Request to the phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = OPEN_RX_STREAM

OPEN RX STREAM REQUEST MSG

sysToken:		4 bytes, unsigned long integer, System defined "token" that must be passed back with the corresponding Close Receive Stream Request.
sysStrmID:		4 bytes, unsigned long integer, System provided stream ID. This field denotes the B channel the connection should assume.
strmCodec		4 bytes, unsigned long integer (bitmap), System selected CODEC to use. Multiple CODECs may be logically Ored into this field.
strmFrameSizeInMS		4 bytes, unsigned long integer, Preferred CODEC frame size for the RX stream (in milliseconds)
isMulticast		4 bytes, unsigned long integer isMulticast =0: no Multicast, ignore mcIpAddress. isMulticast =1: the stream must be bound to the mcIpAddress Multicast address.
mcIpAddress:		structure
	ip_addr	4 bytes, unsigned long integer, Multicast address to receive on

	ip_port	2 bytes , unsigned short integer, Multicast port number to receive on.
		Note that due to long word alignment, there may be two bytes of filler following this field.
SrcIpAddress:		structure: IGNORED BY THE IP PHONE.
	ip_addr	4 bytes, unsigned long integer, The ip address of the device that will be transmitting to the phone.
	ip_port	2 bytes , unsigned short integer, port number used by the device that will be transmitting to the phone.
		Note that due to long word alignment, there may be two bytes of filler following this field.
noSilence		4 bytes, unsigned long integer, noSilence =0: no silence suppression applied by the transmitting end noSilence =1: silence suppression is being applied by the transmitting end

Open Receive Stream Acknowledgement from the IP Phone to the system:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = OPEN_RX_STREAM_ACK

OPEN_RX_STREAM_ACK_MSG

reqStatus:		4 bytes, unsigned long integer, Success/Failure Result of the request
sysToken:		4 bytes, unsigned long integer, System provided "token" from the request message
rxConnectionID:		4 bytes, unsigned long integer, Device selected stream/connection identifier. The IP Phone returns the value of the sysStrmID (B channel) in this field
rxStrmIpAddress:		structure
	ip_addr	4 bytes, unsigned long integer, The local ip address that will receive stream
	ip_port	2 bytes , unsigned short integer, local port number to receive on.

Close Receive Stream Request from the system to the IP Phone:

ProtoType = MITEL_INTERNAL

DevNum = N where N=0,1,2,....n
msgType = CLOSE_RX_STREAM

CLOSE_RX_STREAM_REQUEST_MSG

sysToken:	4 bytes, unsigned long integer, System defined "token" that was given with the Open Receive Stream Request.
sysStrmID:	4 bytes, unsigned long integer, Id of RX stream/connection (B channel) to close

Close Receive Stream Acknowledgement from the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = CLOSE_RX_STREAM_ACK

CLOSE_RX_STREAM_ACK_MSG

reqStatus:	4 bytes, unsigned long integer, Success/Failure Result of the request
sysToken:	4 bytes, unsigned long integer, System provided "token" from the request message
rxStrmStats:	structure: Stream statistics upon closure
Packets.recv	4 bytes, unsigned long integer, number of RTP packets received
Bytes.recv	4 bytes, unsigned long integer, number of voice octets received
Errors.rxStream	4 bytes, unsigned long integer, number of RTP errors received
Jitter.rxStream	4 bytes, unsigned long integer, estimate of average jitter over duration of call.
Duration.rxStream	4 bytes, unsigned long integer, duration of call in seconds
IpAddress.src:	structure
ip_addr	4 bytes, unsigned long integer, the local ip address
ip_port	2 bytes, unsigned short integer, the local port number.

Open Transmit Stream Request to the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = OPEN_TX_STREAM

OPEN_TX_STREAM_REQUEST_MSG

sysToken:	4 bytes, unsigned long integer, System defined "token" that must be passed back with the corresponding Close Transmit Stream Request.

sysStrmID:		4 bytes, unsigned long integer, System provided stream ID. This field denotes the B channel the connection should assume.
strmCodec		4 bytes, unsigned long integer (bitmap), System selected CODEC to use. Multiple CODECs may be logically Ored into this field.
strmFrameSizeInMS		4 bytes, unsigned long integer, Preferred CODEC frame size for the TX stream (in milliseconds)
destStrmIpAddress:		structure
	ip_addr	4 bytes, unsigned long integer, The IP address of the device to transmit to.
	ip_port	2 bytes , unsigned short integer, port number used by the device that will be transmitting to the phone.
		Note that due to long word alignment, there may be two bytes of filler following this field.
qosLevel		4 bytes, unsigned long integer, QoS level requested. If 0xffffffff, then no 802.1Q tag, else if 0-7, assume 802.1Q tag and set priority field to the qosLevel
noSilence		4 bytes, unsigned long integer noSilence =0: disable silence suppression on the Tx stream noSilence =1: enable silence suppression on the Tx stream

Open Transmit Stream Acknowledgement from the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = OPEN_TX_STREAM_ACK

OPEN_TX_STREAM_ACK_MSG

reqStatus:		4 bytes, unsigned long integer, Success/Failure Result of the request
sysToken:		4 bytes, unsigned long integer, System provided "token" from the request message
txConnectionID:		4 bytes, unsigned long integer, Device selected stream/connection identifier. The IP Phone returns the value of the sysStrmID (B channel) in this field
txStrmIpAddress:		structure
	ip_addr	4 bytes, unsigned long integer, The local IP address that will transmit stream
	ip_port	2 bytes , unsigned short integer, local port number the phone will transmit from.

Close Transmit Stream Request to the IP Phone

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n

msgType = CLOSE_TX_STREAM

CLOSE_TX_STREAM_REQUEST_MSG

sysToken:	4 bytes, unsigned long integer, System defined "token" that was given with the Open Transmit Stream Request.
sysStrmID:	4 bytes, unsigned long integer, Id of TX stream/connection (B channel) to close

Close Transmit Stream Acknowledgement from the IP Phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = CLOSE_TX_STREAM_ACK

CLOSE_TX_STREAM_ACK_MSG

reqStatus:		4 bytes, unsigned long integer, Success/Failure Result of the request
sysToken:		4 bytes, unsigned long integer, System provided "token" from the request message
txStrmStats:		structure: Stream statistics upon closure
	Packets.sent	4 bytes, unsigned long integer, number of RTP packets sent
	Bytes.sent	4 bytes, unsigned long integer, number of voice octets sent
	Errors.txStream	4 bytes, unsigned long integer, number of RTP errors sent. IGNORE, NOT RELEVENT
	Jitter.txStream	4 bytes, unsigned long integer, estimate of average jitter over duration of call. IGNORE, NOT RELEVENT
	Duration.txStream	4 bytes, unsigned long integer, duration of call in seconds
	IpAddress.dest:	structure
	ip_addr	4 bytes, unsigned long integer, the local IP address used to Tx
	ip_port	2 bytes , unsigned short integer, the local port number used to Tx.

Detailed Description of Connection Parameters

reqStatus (Success/failure codes):

MTL_SUCCESS	0x00000000
MTL_FAILURE	0x00000001
MTL_NO_PERMISSIONS	0x00000002
MTL_NO_RESOURCES	0x00000003
MTL_INVALID_DEVICE	0x00000004
MTL_INVALID_REQUEST	0x00000005

SysStrmID:

IP Set Stream IDs: (NOTE: TX is always even) used for sysStrmID of Tx & Rx connect requests

STREAM_ID_IP_SET_TX_1	0x00000000	// B1 TX
STREAM_ID_IP_SET_RX_1	0x00000001	// B1 RX
STREAM_ID_IP_SET_TX_2	0x00000002	// B2 TX
STREAM_ID_IP_SET_RX_2	0x00000003	// B2 RX

devCodecs bitmap:

NO_CODEC_SUPPORT	0x0	(000 00000000)
G711_ULAW64	0x1	(000 00000001)
G711_ALAW64	0x2	(000 00000010)
G728	0x4	(000 00000100)
G729	0x8	(000 00001000)
G729_ANNEXB	0x10	(000 00010000)
G729_ANNEXA_w_ANNEXB	0x20	(000 00100000)
G723	0x40	(000 01000000)
G7231_ANNEXC	0x80	(000 10000000)
Placcholder1	0x100	(001 00000000)
Placcholder2	0x200	(010 00000000)
Placeholder3	0x400	(100 00000000)
INVALID_CODEC	0x7FF	(111 11111111)

qosLevel:

QOS_LEVEL_NONE	0xffffffff
QOS_LEVEL_0	0x00000000
QOS_LEVEL_1	0x00000001
QOS_LEVEL_2	0x00000002
QOS_LEVEL_3	0x00000003
QOS_LEVEL_4	0x00000004
QOS_LEVEL_5	0x00000005
QOS_LEVEL_6	0x00000006
QOS_LEVEL_7	0x00000007

One important system administration requirement for IP phone systems is to provide a mechanism for updating the IP address for a device (e.g. an IP phone) connected to the Ethernet PBX 3. The following messages are generated and exchanged between the IP phone and the PBX ~~used~~ to implement this functionality:

Device IP address update request to the phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_IP_UPDATE

DEVICE_IP_UPDATE_REQUEST_MSG

devNumber		4 bytes , unsigned long integer, Number of device: Master, Slave01, Slave02, ...
oldIpAddress:		structure
	ip_addr	4 bytes , unsigned long integer, old IP Address of device
	ip_port	2 bytes , unsigned short integer, old port number of device Note that due to long word alignment, there may be two bytes of filler following this field.
newIpAddress:		structure
	ip_addr	4 bytes , unsigned long integer, new IP Address of device
	ip_port	2 bytes , unsigned short integer, new port number of device

Device IP address update acknowledgement from the phone:

ProtoType = MITEL_INTERNAL
DevNum = N where N=0,1,2,....n
msgType = DEVICE_IP_UPDATE_ACK

DEVICE_IP_UPDATE_ACK_MSG

reqStatus:	4 bytes , unsigned long integer, Success/Failure Result of the request

Parameters Description

reqStatus (Success/failure codes):

MTL_SUCCESS	0x00000000
MTL_FAILURE	0x00000001
MTL_NO_PERMISSIONS	0x00000002
MTL_NO_RESOURCES	0x00000003
MTL_INVALID_DEVICE	0x00000004
MTL_INVALID_REQUEST	0x00000005

devNumbers:

MASTER_DEVICE 0x00000000
Where Set=0, and any attached devices will be numbered MASTER_DEVICE + n where n >= 1

Finally, as indicated above, the messaging protocol of the present invention allows for the encapsulation of "legacy" Minet messages (i.e. MTS 22 messages) to and from the IP phones. The following message format is used:

Wrapper structure for MINET messages to and from the IP Phone:

ProtoType = MINET_MTS22
DevNum = N where N=0,1,2,....n
msgType = MINET_WRAPPER

MINET_WRAPPER_MSG

msgLen:	4 bytes , unsigned long integer, length of the following MINET message.
msg[MAX_MINET_SIZE]	array unsigned char, the MTS22 MINET message

Parameters Description

MAX_MINET_SIZE 160

In summary, according to the present invention, a method of controlling telephone connections for internet protocol communications comprises providing a messaging protocol ~~is provided~~ for wrapping or encapsulating messages exchanged between an IP phone and a PBX, the message protocol using a general message template having a Protocol Header and an IP Message body, along with a collection of messages which conform to the protocol, for controlling IP phones within an Ethernet-based PBX system. The invention has particular applicability as a message interface method for use in communication from Mitel's IP Phones to Mitel's IP enabled PBXs. The message interface method is compatible with an H323 Voice Gateway implementation.

Alternatives and variations of the invention are possible. For example, the protocol can be adapted to control voice/data switching on any IP centric node. In other words, the protocol is not constrained to phones but, rather, can be applied to any internet appliance that is a client to the IP centric PBX. Within the PBX, the

protocol can be used by call control in order to control the switching fabric. All such embodiments, modifications and applications are believed to be within the sphere and scope of the invention as defined by the claims appended hereto.

I Claim: